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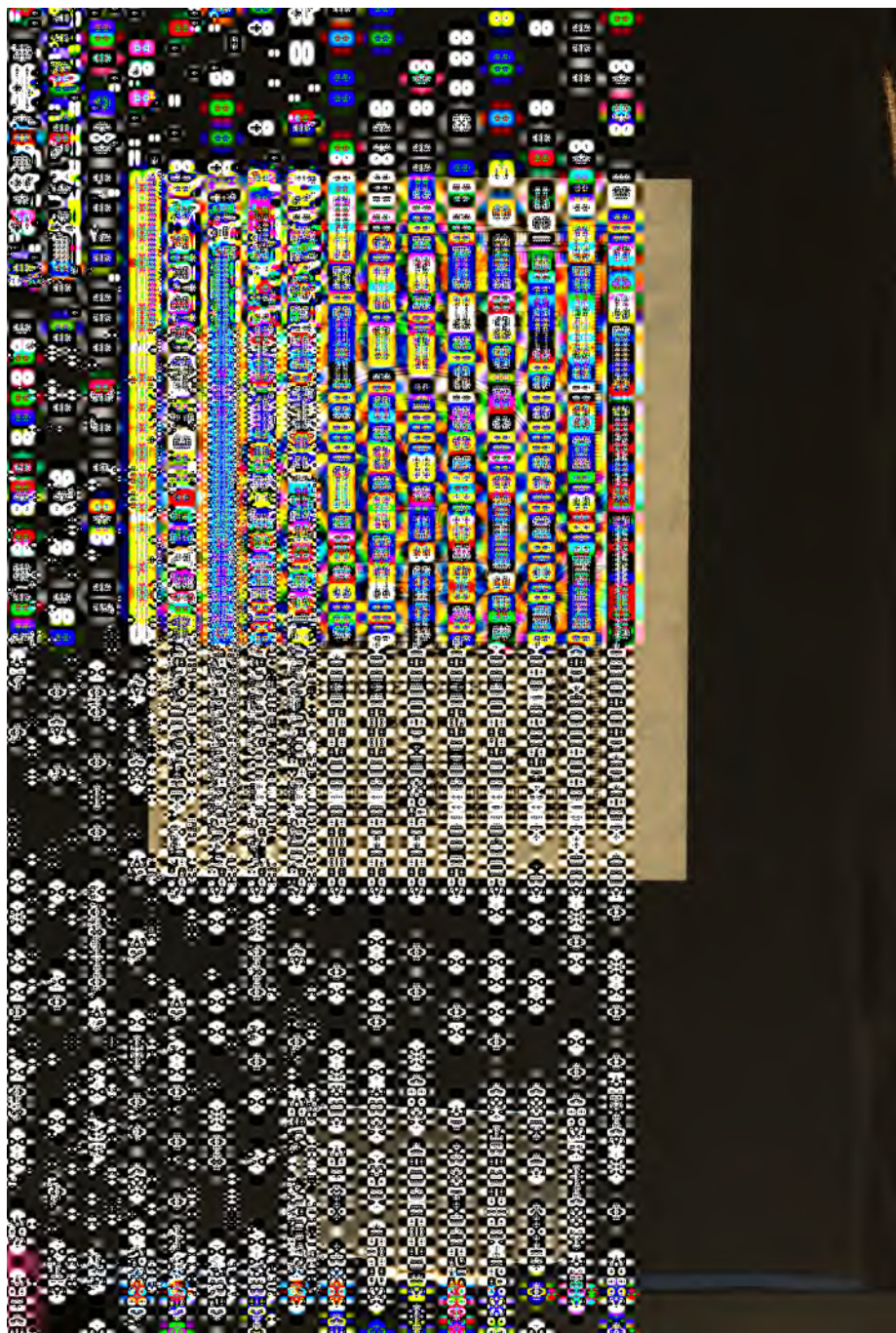
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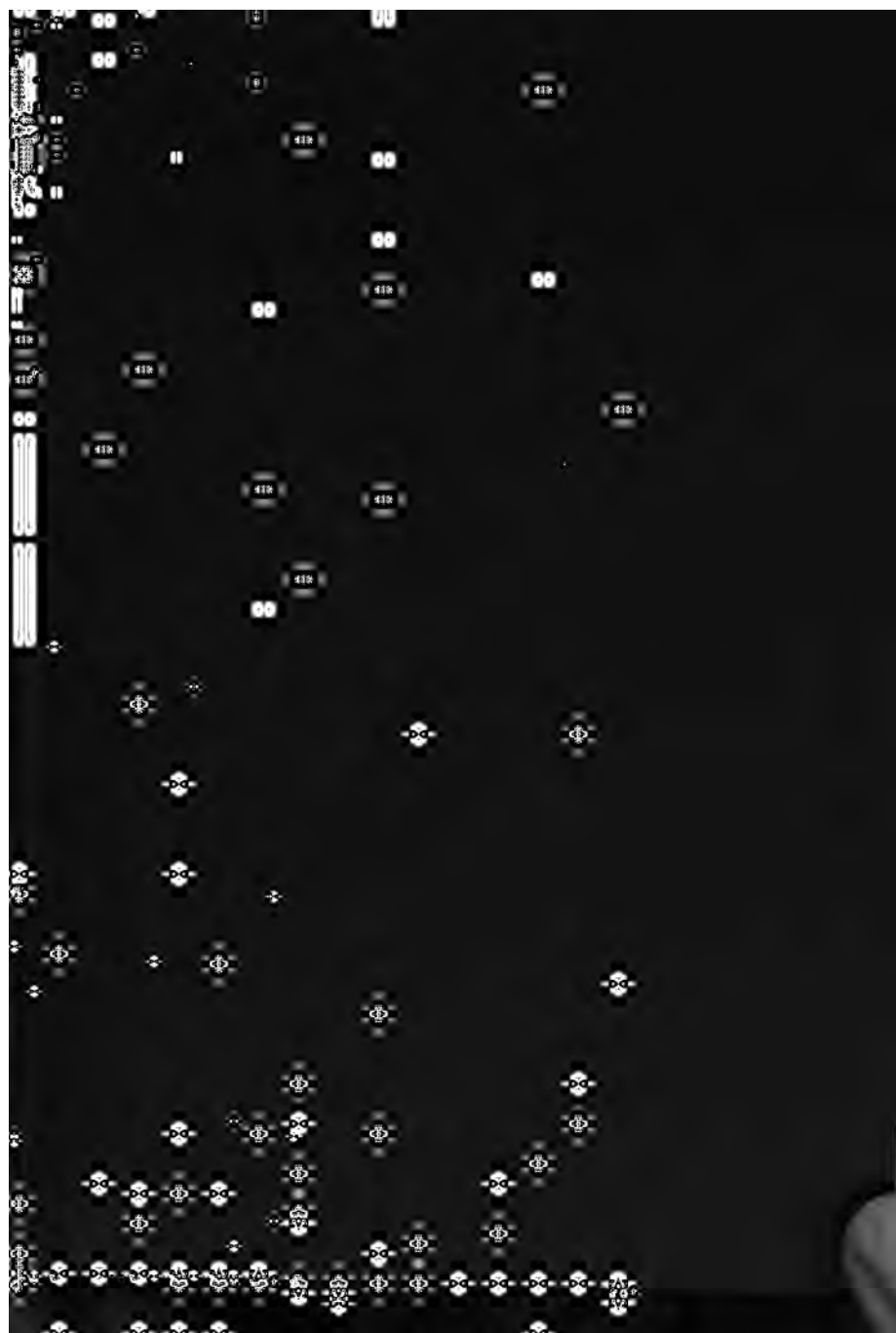
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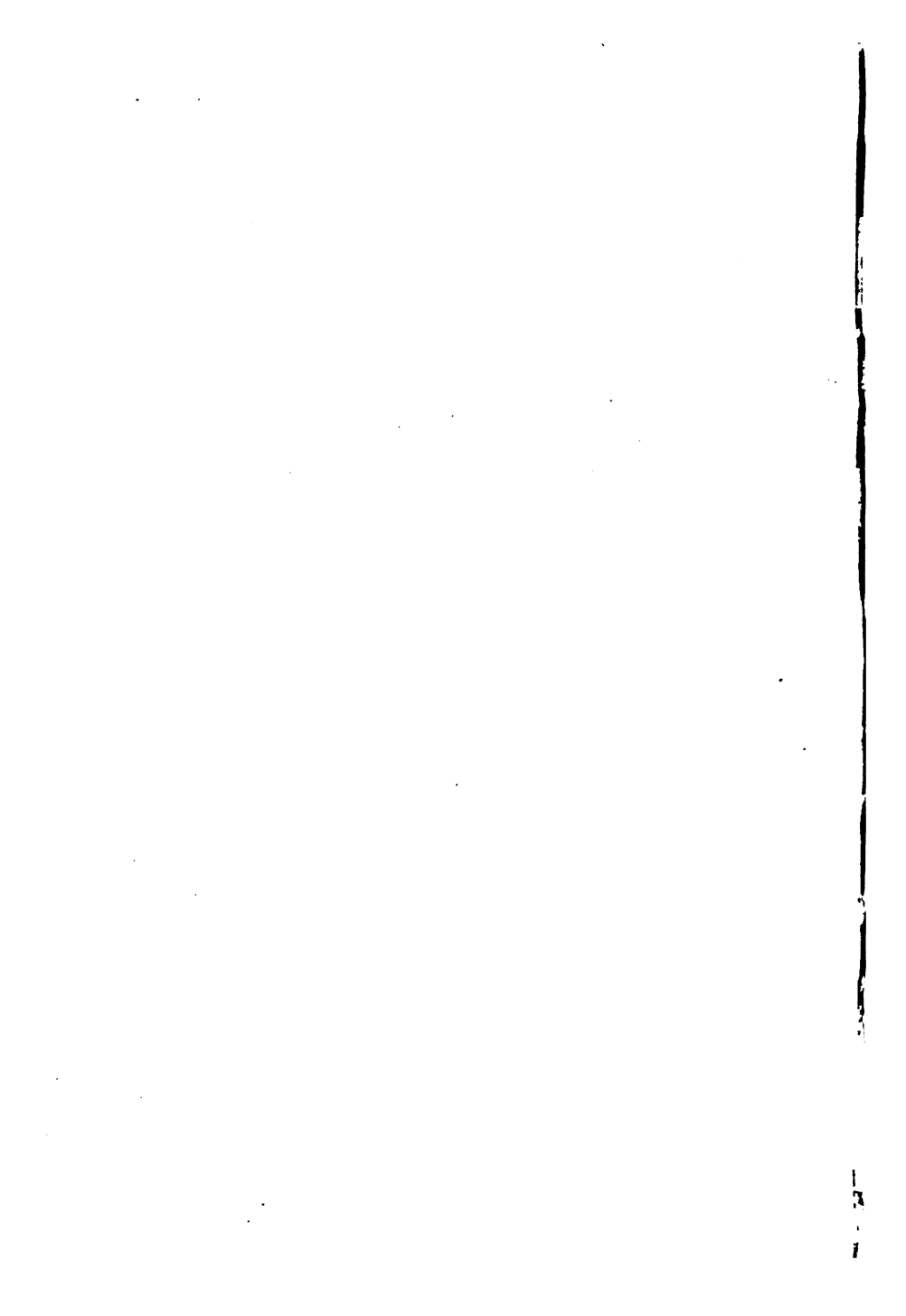
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**LECTURES ON MEDICAL ELECTRICITY
TO NURSES**

LECTURES
ON
MEDICAL ELECTRICITY
TO NURSES

AN ILLUSTRATED MANUAL

BY

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WITH 23 ILLUSTRATIONS

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PREFACE

WHEN giving some lectures to nurses already trained in general nursing, on the principles of electrical nursing, the lament that there was no book on the subject reached me several times.

There was a suggestion that if my lectures were amplified a little, and illustrated, they might meet the requirement.

This manual is the outcome of the suggestion, and the language has been made as clear and elementary as possible. I have examined nurses on the subjects of the lectures, and found they could take an intelligent interest in the progress of the patients and carry out their treatment safely.

The manual is throughout arranged for Hospital-trained nurses, who may be seeking employment in the electrical department of a Hospital, or undertaking the treatment of a private patient under the supervision of a medical man.

I sincerely hope it may be found useful and helpful for these purposes, and also to naval and military nurses.

J. DELPRATT HARRIS.

EXETER, 1913.

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TABLE OF CONTENTS

INTRODUCTORY.

	PAGE
The kind of nurse that makes a good electrical nurse	1

LECTURE I.

Static or frictional electricity. Positive and negative. Conductors and non-conductors. Influence machines. The care and testing of machines.	
Explanation of terms used - - - - -	4

LECTURE II.

Magnetism and galvanism. Cells and batteries. Description of apparatus in use - - - - -	20
---	----

LECTURE III.

Galvanism continued. A sitting described. Symbols explained - - - - -	32
---	----

LECTURE IV.

Faradic electricity. Machines described. A sitting described. Schnee's four-celled bath. Ionic treatment. Immersion baths - - - - -	37
---	----

LECTURE V.

Finsen light treatment. Ultra-violet light treatment. Radium treatment. Roentgen X-ray treatment. Kidney photographs, Ringworm treatment -	51
--	----

LECTURE VI.

High frequency. Diathermy. Radiant heat. Coloured	PAGE
light. Nursing a radiant heat case - - -	69

WRINKLES.

On static electricity, on the constant current, on detect-	
ing faults, on Faradism, on X-ray apparatus, on	
tubes, on Finsen light, on amalgamating zinc	
plates - - - - -	79
INDEX - - - - -	86

LIST OF ILLUSTRATIONS

FIG.	PAGE
1. Glass rod and scraps of paper - - -	4
2. Pith balls and glass rod - - -	6
3. Wimshurst static machine - - -	9
4. Ditto enclosed in glass case - - -	11
5. Gold leaf electroscope - - -	15
6. Leyden jar - - -	16
7. Sinusoidal curves - - -	19
8. Lines of force in bar magnet - - -	21
9. Galvanic or voltaic cell - - -	23
10. Schall's continuous current battery - - -	27
11. Milliampere meter. Cavendish Co. - - -	31
12. Faradic induction coil - - -	39
13. Spamer's Faradic battery. Newton & Co. - -	40
14. Schnee's four-celled bath - - -	44
15. Portable galvanic and Faradic battery - -	49
16. Finsen-Reyn electric arc lamp - - -	52
17. Miller's condenser spark lamp - - -	54
18. A modern induction coil. Newton & Co. - -	57
19. An X-ray outfit. Cavendish Co. - - -	59
20. Induction coil for high frequency - - -	69
21. Oudin's resonator - - -	71
22. Newton's condensation couch - - -	73
23. Radiant heat bath with arc projector - -	76

MEDICAL ELECTRICITY FOR NURSES

INTRODUCTORY

A NURSE who is training at a large general hospital, as a rule, has her first introduction to electrical work by bringing down a patient for treatment to that department. She there sees in the crowded rooms an array of instruments of a kind she has not seen in the wards. There are some that buzz with a curious vibratory sound, some that are noiseless but move a pointer that the nurse in charge appears anxiously watching, and some that are used in darkened rooms that give off a curious light. Perhaps in an absolutely dark room she will be asked to feed a patient, which will tax all her skill and patience, not from its intrinsic difficulty but that it must be done in the dark. In another room a patient is lying on a couch apparently enjoying a rest, but as clocks are ticking, sand-glasses running, and the patients constantly changing, it is evident there must be something going on which at present is mysterious to her.

She need not take fright, however, and think it is all quite incomprehensible, for when she comes to

2 MEDICAL ELECTRICITY FOR NURSES

study the subject she will find that after mastering certain rules and understanding certain principles, the subject begins to straighten out. Most probably she will have the opportunity to attend a course of lectures on the subject, and see experiments to explain to her the reason of things. This handbook has been put together to help her to get the names more clearly in her head, to guard her against things she must not do, and help her in doing certain things she must do.

Sometimes, when a lecturer endeavours to make some point clear to his class, some technical term or expression escapes him, the exact meaning of which is not familiar to a nurse, which therefore mystifies her. It is hoped this book may prove a useful adjunct to the lectures in making the meaning of such a term more clear.

She must remember there is nothing more mysterious in electricity than in other sciences, if only she will study it bit by bit, and get to know the meaning of the terms made use of.

A careless, happy-go-lucky nurse has no place in the electrical department of a general hospital. No branch of medicine is more exacting as to detail than is electrical work. Every connection must be absolutely correctly made, every wire tightly held by its binding screw and brightly polished, or no action, or, worse still, faulty action is the result, with pain and perhaps danger to the patient.

During her training in the electrical department

each individual nurse should experience in her own person each form of medical electricity commonly used on patients, with a view to getting over any nervous feeling she may have, and also knowing the kind of discomfort patients are subjected to who are undergoing treatment. A nervous nurse inclined to ejaculate at sudden noises, and sparks, is disconcerting to patients and annoying to the medical officer.

If, after a first reading of some of these lectures, a nurse feels a little at sea, she is urged to continue her reading, for frequently she will get a better grasp of a point she is doubtful about when the matter is presented in another aspect with further explanations.

Repetition will be found in some places. This has been made purposely, first because it is nature's own mode of instructing us, and, secondly, because a nurse has to know a certain point quickly sometimes, and time does not allow of a lengthy search even in a small manual.

LECTURE I

STATIC OR FRICTIONAL ELECTRICITY PRINCIPLES OF ELECTRICITY

IF a piece of glass, amber, or sealing-wax be rubbed with a dry cloth, it acquires the power of attracting light bodies, as feathers, dust, or bits of quite dry paper; this is the result of a new and peculiar condition of the body rubbed called electrical excitation.

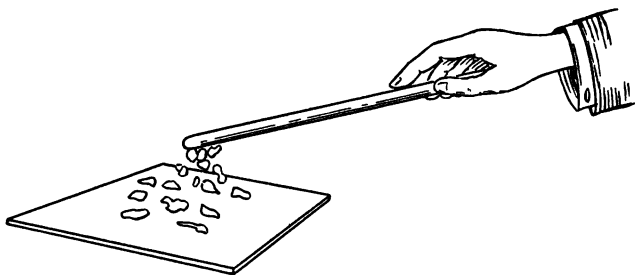


FIG. 1.—GLASS ROD AND SCRAPS OF PAPER.

If a light downy feather or pith ball be suspended by a thread of white silk, and a dry glass tube excited by rubbing be presented to it, the feather will be strongly attracted to the tube, adhere to its surface for a few seconds, and then fall off. If the tube be now excited anew and presented to the feather, the latter will be strongly repelled.

The same experiment may be repeated with a stick of shellac or resin ; the feather suspended by a white silk thread in its ordinary state will be drawn towards the excited body, and, after touching, again driven from it with a certain degree of force.

Now, let the feather be brought into contact with the excited glass, so as to be repelled by that substance, and let a piece of excited sealing-wax be presented to it ; a degree of attraction will be observed far exceeding that exhibited when the feather is in its ordinary state. Or again, let the feather be made repulsive for sealing-wax, and then the excited glass be presented ; strong attraction will ensue.

To distinguish these two different forms of excitement, certain arbitrary and distinctive terms are employed ; it is customary to call the electricity manifested by glass rubbed with silk, **positive** or **vitreous**, meaning glassy, and that developed in the case of shellac and bodies of the same class rubbed with flannel, **negative** or **resinous**.

The repulsion shown by bodies in the same electrical state is taken advantage of to construct instruments for indicating electrical excitement and pointing out its kind. Two little balls made out of the pith of the elder plant, hung by threads of cotton or flax, or very fine metal wires, serve this purpose ; they open out when excited, in virtue of their mutual repulsion, and show, by their degree of divergence, the extent to which the excitement has been carried. A pair of gold leaves suspended to a metal rod having

6 MEDICAL ELECTRICITY FOR NURSES

a brass plate on its upper end constitute a much more delicate arrangement, and one of great value and in constant use. The flask must be dried and warmed before use, and securely corked, the rod piercing the cork well varnished. Such an instrument is called an **electroscope**.

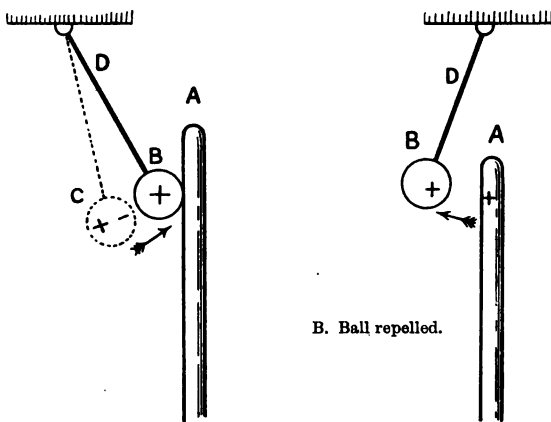


FIG. 2.—PITH BALL ATTRACTED AND REPELLED BY EXCITED GLASS ROD.

A. Glass Rod; B. Pith Ball; C. Position of ball at beginning of attraction; D. Silk cord suspending pith ball. The signs plus and minus show positive and negative electricity.

When it is required to know the kind of electricity about to be used, the leaves of the electroscope are made to diverge by a known kind; they show by an increased or diminished divergence the state of an electrified body brought into their neighbourhood.

One kind of electricity cannot be developed without the other; the rubber and the body rubbed always assume opposite states; and the positive

CONDUCTORS AND NON-CONDUCTORS 7

condition on the surface of a mass of matter is invariably accompanied by a negative state in all surrounding bodies.

When any electrified body is put in communication with the earth by any one of the class of substances called conductors of electricity, all signs of electrical disturbance cease by virtue of what is called **discharge**.

Conductors of electricity, which thus permit discharge to take place through their mass, are contrasted with another class of substances called **Non-conductors** or insulators. The difference, however, is rather one of degree than of kind; the very best conductors offer a certain resistance to the electrical discharge, and the most perfect insulators permit it to a small extent. The metals are by far the best conductors; glass, silk, shellac, dry gas, or vapour of any sort, the very worst; and between these there are bodies of all degrees of conducting power.

Electrical discharges take place silently and without disturbance in good conductors of sufficient size. But if the charge be very intense and the conductor very small or imperfect from its nature, it is often destroyed with violence.

When a break is made in a conductor employed in effecting the discharge of a highly-excited body, **disruptive** or **spark discharge**, so well known, takes place across the intervening air, provided the ends of the conductor be not too distant.

8 MEDICAL ELECTRICITY FOR NURSES

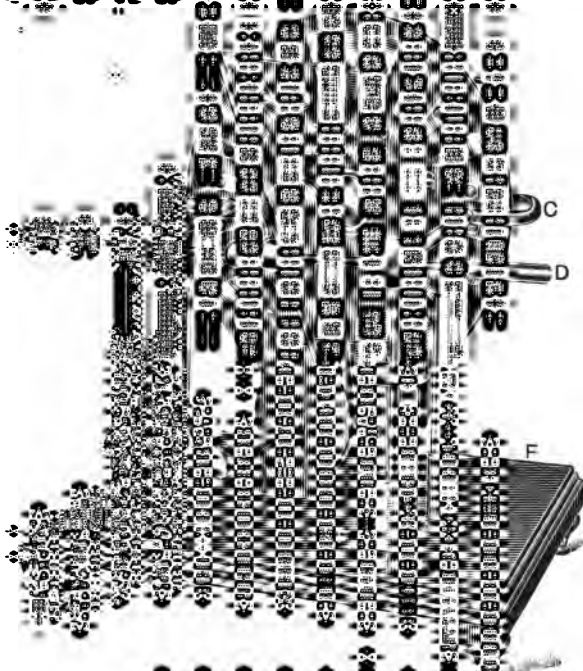
For medical work a means of obtaining this form of electricity in far greater quantity than can be obtained from glass rods is needed. The glass rod or tube was at first enlarged to a cylinder many inches in diameter, but still it was essentially a tube, and gave considerable quantities of electricity when made to turn round on its long axis pressing as it turned against cushions suitably arranged. In another apparatus the glass was formed into circular flat plates or discs. In each form the electricity was excited by rubbing, that is **friction**, and so it gave rise to the term **frictional electricity**.

Gradually it was found that this form of electricity could be produced by other means than rubbing, and so the term became inconvenient and another was substituted, namely, **static electricity**. This is the term mostly used in medical work when this form is indicated. It was further found that these non-rubbing machines, though still made of glass, gave out enormous quantities of electricity compared to the old rubbing or frictional electrical machines. Eventually, glass being a brittle substance unfit for rough travelling, it was found that plates of vulcanite might be substituted.

The best of all these machines is that invented by Mr. Wimshurst and goes by his name as a Wimshurst Influence Machine. Briefly, it consists of a framework stand carrying a long piece of iron rod. On this rod is threaded a pair of glass or vulcanite discs

MACHINE 9

Each disc
has a groove
that each



attached
Leyden

The surface
of the
is called
mass.

10 MEDICAL ELECTRICITY FOR NURSES

Neutralizing Rods are attached to the iron rod axis which are so bent that they touch the brass buttons by means of tufts of gold fringe.

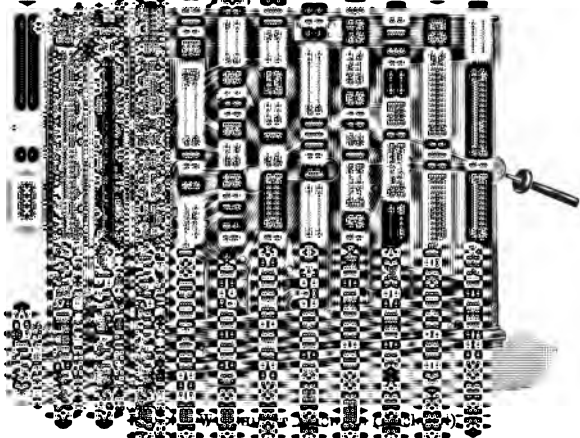
The position of these neutralizing rods is of the greatest importance. It may, however, be easily remembered by comparing the rotating discs to the face of a clock, when the neutralizing rods should indicate five minutes to eleven and five and twenty minutes past.

Two pairs of **combs** made of metal collect the electricity from each pair of discs and deliver their charge to two large brass tubes or knobs, called **prime conductors**, when it is found one prime conductor is charged with vitreous or positive electricity, whilst the other is charged with resinous or negative electricity.

Each prime conductor is put into metallic connection with the inside of a **Leyden jar** by means of a fine wire, whilst the outsides of the Leyden jars are in metallic connection with each other. Each prime conductor carries a **discharging rod** or **pole**, both of which are made to converge.

The pairs of plates may be increased in size or number, but for medical purposes four to six pairs are found most practical. On rotating the discs of such machines, sheaves or cascades of sparks may be seen leaping across from one discharging rod to the other from a distance of some inches, according to the size of the instrument. The plates are often enclosed in a glass case to avoid dust. Although

common as well as affected by the damp the cold prevent them es, in the



given off ; the handle or so a conditions to get this difficulty the actuat attempting may be ex continent

12 MEDICAL ELECTRICITY FOR NURSES

away from the large oceans, and in America, such machines act well and with fair certainty, and are in daily use. In England, they are less frequently used.

The action of these machines is strictly unidirectional, that is to say, the positive prime conductor gives off nothing but positive electricity, and the negative prime conductor nothing but negative electricity. There is, however, a liability for the poles to become reversed between the times the machine is used. It does not seem that this often occurs unless **batteries of Leyden jars** are charged. Still, it is necessary to test the poles in the manner presently described, by means of the electroscope, each day it is used.

A nurse can look after such machines, and the points she has to see to are these. She must remove all dust from the plates and accessory apparatus. She must prevent the metal portions from becoming coated with rust. This is the more likely to occur when the apparatus is enclosed in a glass cabinet. A light hand with a feather and silk handkerchief is necessary. She must see that each neutralizing rod is correctly placed. She must see that the collecting combs are in their proper position, clean, and the points sharp. Also that the prime conductors are in connection with the Leyden jars and the outside coating of each Leyden jar is in connection with that of the opposite jar. That the bands act properly and are not too loose, and that the

plates rotate correctly in opposite directions. Also that the rotating handle or motor power is in order, and that the discharging rods are properly placed. The glass or vulcanite pillars carrying the apparatus must be wiped free from all dew during use. It is well to remember also that on ceasing to use such a machine it remains itself charged, being well insulated by the glass or vulcanite pillars. A small and quite painless spark, therefore, takes place from either or both discharging rods on touching them. This may cause a nurse to jump unless she is warned of it ; but if a knuckle is presented once or twice and the spark taken, the machine is then quite discharged ; but this must be done on both sides, the positive and negative.

To make use of this form of electricity medically, besides the machine, an insulating stool or platform is required, made of strong wood with long glass legs. It should be just large enough to hold a patient sitting on a chair. See that ladies' clothing does not touch the ground. Metal chains are used to connect the discharging poles with the patient and various electrodes suitable for high tension electricity.

To conduct a sitting, the patient has a portion of his clothing removed if a **local ailment** exists, and the part exposed. This is not absolutely necessary, but if not carried out the clothing emits a nasty odour from singeing, and cotton-wool may take fire. But if no local lesion exists, and a **static electric bath** is to be given, the clothing may remain untouched. The patient then either stands on the

14 MEDICAL ELECTRICITY FOR NURSES

insulated stool or sits on the insulated chair. The feet or hands are next connected to the prime conductor on the positive side. If no instrument is presented locally, on charging the patient he feels a curious sensation as though cobwebs were touching him. About ten milliamperes are now passing through him, and the machine must be kept continuously rotating. If an electrical comb set on a handle but connected with the ground, or opposite pole of the machine, is presented to any portion of the skin, a breeze is felt, and sparks may pass if the comb is held too near. This produces an invigorating effect, especially when applied to the spine. If a brass ball is similarly presented, sparks occur and muscles are made to move.

A sitting lasts for ten to fifteen minutes.

A nurse in charge of such a machine should know how to prove the polarity of the discharging poles or rods, and should ascertain this at the commencement of a day's sittings. It is accomplished by means of a glass rod, a piece of silk dried and warmed at the fire, an electroscope, a **proof plane**, and the Wimshurst or any other static machine.

It is one of the laws of electricity that similar electricity always repels, whilst opposite electricities always attract each other.

Let the gold-leaf electroscope be placed on a level table. Rub the glass rod held in one hand with a silk handkerchief held in the other. Approach the excited glass rod near the disc on the electroscope

and observe the two pieces of gold leaf diverge from each other. As soon as the excited glass rod is removed the two pieces of gold leaf again fall together.

Next excite the glass rod again, and whilst holding it firmly quite close to, but not touching, the disc, momentarily touch the opposite side of the

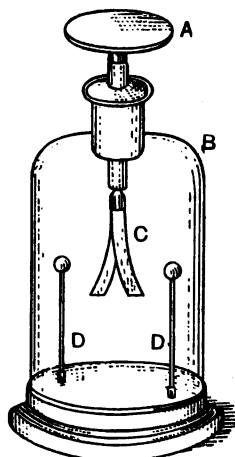


FIG. 5.—GOLD-LEAF ELECTROSCOPE.

A. Brass plate; B. Glass jar having a wooden or metallic base, no glass bottom; C. Gold leaves in metallic connection with brass plate; D D. Two metallic balls on stiff wire in connection with table.

disc with a finger of the other hand whilst the excited glass rod is near the disc. Withdraw at once the finger which touched the disc, and lastly remove the excited glass rod. If this is adroitly done, the two leaves stick out from each other and will remain divergent many minutes. Next, the nurse must hold the proof plane by the glass handle and make the brass touch one of the discharging poles or rods

NURSES

minute or more. Next, the disc of the machine is rotated, and we see what happens. Electricity from an electrically positive electrode tends to diverge. If the electrodes repel, we may say that the electricity is repelled from the proof plane. Since dissimilar charges attract, the proof plane of plane was attracted to the charging rod it

knowledge of electricity, we can make them clearer. In order to obtain a certain amount of electricity, it is not too frequent to use them in our

in glass jar is placed outside with a wire taken to leave the copper part unconnected in a communicating chain. The chain is connected with

the earth, and the knob put in contact with the conductor of the static machine, the inner and outer surfaces of the glass become respectively positive and negative until a very great degree of intensity has been attained. On completing the connection between the two coatings by a metallic wire or rod discharge occurs in the form of an exceedingly bright spark, accompanied by a loud snap ; and if the human body be interposed in the circuit, the peculiar sensation of the electric shock is felt at the moment of its completion. When several of such jars are connected, the whole collection is spoken of as a **Leyden jar battery**.

Combs. The combs of an electrical machine are metallic points projecting from a metallic conductor comb-wise. They are set so as to collect the electricity accumulated on the glass or vulcanite plates as they rotate.

Prime Conductors. This name is given to the tubes of metal which hold the combs in position.

Discharging Poles. These are metallic conductors usually of brass tubing attached to the prime conductors at one end and having brass balls at the other. If the brass balls are of unequal size, the smaller should be on the positive side. Patients are attached to the machine through the discharging poles.

Electroscope. This is an instrument used for the purpose of betraying the presence of electricity. It will also detect whether the electricity be positive

18 MEDICAL ELECTRICITY FOR NURSES

or negative. It is composed of a glass jar with a fairly broad mouth closed by a cork or piece of wood. Through the cork or wood is a piece of stout brass wire bent in such a manner that two pieces of gold leaf hang from it in a parallel manner inside the jar. The top of the stout brass wire carries a flat disc of brass usually.

Proof Plane. This instrument is composed of a small disc of any metal about the size of a shilling, or it may be a brass ball of similar size, mounted on a glass handle, to insulate it.

Insulators. The function of these is to hold conducting rods or pieces of apparatus. They are made of non-conducting material such as glass, good porcelain, vulcanite, etc.; by so doing, direct electrical communication between the conducting rod or apparatus and the earth is cut off, or, in other words, they insulate them.

Conductors are those metallic substances on which electricity travels. All the metals, including quicksilver, and all their salts in water are such, but no two metals conduct equally well. Pure water conducts badly until some acid is added, when it conducts well.

Non-conductors are substances such as glass, amber, resin, dry wood, vulcanite, silk, dry skin, paraffin, sealing-wax, dry air, flannel, and textile fabrics if dry.

Electromotive Force. This term is used in electrical science as a measure of the pressure of

electricity. So it is spoken of as high electromotive force or low electromotive force. Static electricity is always of high electromotive force.

Graph is a term used to denote a chart, like a temperature chart, arranged to show how certain electrical forces act. The graph of a galvanic battery is shown as a level straight line without breaks, or rise, or fall, thus —————

The graph of a dynamo sending direct current is shown thus — — — — —

The gradual rise and fall of an alternating current is shown thus as a graph, the curves passing the

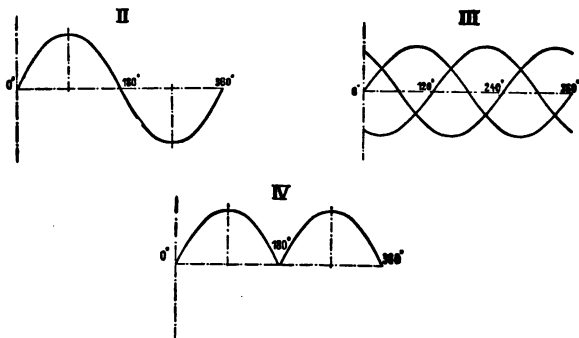


FIG. 7.—“SINUSOIDAL CURVES.”

zero line indicating alternate plus and minus impulses. Number II.

The three-phase sinusoidal interlacing curves can also be shown conveniently as a graph. Number III.

Also the gradual rise and fall of direct current dynamo machines of various types. Number IV.

LECTURE II

MAGNETISM AND GALVANISM

THOSE substances are called magnets that have the power of attracting iron, nickel, or cobalt, if placed close to them. Magnets may be natural or artificial.

Natural Magnets are composed of the magnetic oxide of iron. This substance is found in magnesia in Asia Minor, in Sweden, as well as other places. They are not very strong.

Artificial Magnets are pieces of iron or steel made magnetic. Artificial magnets may be **permanent** or **temporary**.

Soft iron, whilst in contact or in close approximation with a magnet, itself becomes magnetic. But on removing the magnet it immediately loses its magnetism. The retention of this power depends on what is called the **coercive force** of the material. Thus steel has so great coercive force that although it takes a longer time to be saturated with magnetism, once saturated it retains that force indefinitely. Therefore a magnet of steel is called a permanent magnet, whilst one of soft iron is called a temporary magnet ; it has little or no coercive force.

Soft iron is used to form **electro magnets**. A horse-shoe-shaped bar of soft iron, each limb encircled many times by a coil of copper wire insulated by being wrapped round with cotton or silk, becomes a very strong magnet as long as a galvanic current of considerable strength is passed through the wire. Directly the current is broken it ceases to be a magnet.

The two ends, of whatever shape the magnet may be, are its poles. One end has a desire to seek the

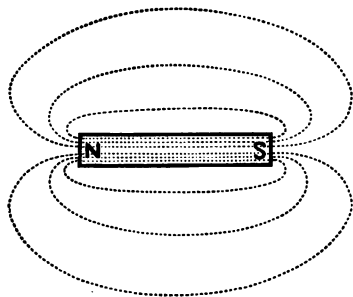


FIG. 8.—LINES OF FORCE OF A BAR MAGNET.

north pole of the earth or any other magnet, whilst the other desires to seek the south pole. An imaginary line drawn through the centre of the magnet joining the two poles is called the **magnetic axis**. One at right angles bisecting it is called the **magnetic equator**.

The space around a magnet is regarded as being full of magnetic **lines of force**, proceeding through the air from one pole to the other, completing their circuit in the substance of the magnet. The space

22 MEDICAL ELECTRICITY FOR NURSES

so occupied outside the magnet is called the **magnetic field**. These lines of magnetic force can be easily made visible by means of iron filings, for they readily pass through cardboard or wood ; and if a sheet of cardboard be placed on a magnet lying on a table, and some filings be sifted evenly on it, the lines at once appear outlined by the filings on gently tapping the cardboard. These lines of magnetic force illustrate an analogy with electricity, in that similar poles repel, whilst dissimilar poles attract each other. Very beautiful curves and intricate figures are formed owing to this law.

We do not speak of positive and negative magnetism, but of north-seeking or south-seeking magnetic poles.

Although magnetism is made so much use of in making and measuring electricity and electrical instruments for medical use, it is not made of any use as a curative means, being apparently quite inert as regards the human body.

The denser metals alone seem impervious to magnetism, and only then if sufficiently thick.

GALVANIC ELECTRICITY

We have studied static electricity, which has been described as of high electromotive force ; we now have to study galvanic electricity, or electricity of low electromotive force.

By means of galvanism we obtain a continuous flow or current of electricity which can be readily

restorative,
 from a
 former is
 or more
 battery. It
 continuous
 consists of
 g-shaped

on.
 ssel.
 hid.

ways zinc,
 piece of
 and some
 fluid or
 sulfuric acid
 acid added
 must not be
 it splash,
 water. Nor
 thing, but
 solution
 electrolytic fluid

24 MEDICAL ELECTRICITY FOR NURSES

must act very much more on one of the metals than the other. It is by this unequal action that electricity is made to flow and form what is called a **current**.

We have, therefore, a jar, two pieces of metal of which one is almost always zinc, and the other copper, platinum, or carbon, and we pour in sufficient **electrolytic fluid** to three parts fill the jar. Still nothing occurs until we join the two pieces of metal by a wire, when copious bubbles are given off from the zinc, and a **current** is established. A nurse must try to remember that this current always flows in the same direction, and that from the zinc comes the negative electricity, whilst from the copper, platinum, or carbon comes the positive electricity.

On disconnecting the wire, or breaking it, the current is said to be broken or opened, and the current ceases ; but it is again renewed on contact being re-established, or closing the current, as it is called.

One galvanic cell would not be strong enough to act on a patient, and so we must join a good many together to get a current sufficiently strong. Eighteen to thirty would be a common number. The whole collection is then called a **galvanic battery**, for two or more cells are always spoken of as a battery.

Putting the cells together in the right manner is called **coupling up** a battery. The proper way to couple up is to begin at the first cell and attach the wire from, say, the positive or copper to its brass

fastening or terminal ; next attach a wire from the zinc in the same jar to the copper in the next jar ; and the zinc again to the copper in the next jar until the last jar is arrived at, when the wire from the last zinc is attached to its brass terminal. The battery is now ready for use.

There are terms used in administering this form of electrical treatment that nurses must try to understand.

Opening and closing the current means breaking open the circuit and thereby stopping it ; and closing the circuit between the battery, instrument, and patient, and thereby establishing the flow of electrical current.

Electromotive Force has been spoken of in the first lecture.

Volts are the units of electromotive force, and a cell is said to give an electromotive force of one volt, or one and a half, or possibly two volts. Batteries may give twenty, thirty, or sixty volts, or any greater number according to the number of cells.

Volt-meters are clock-like instruments with one pointer for measuring the number of volts.

Amperes denote the quantity of current that has been driven through by the pressure of the volts.

Milliamperes are the thousandth part of an ampere ; 0.001 as they are written ; for the human body would be dangerously hurt by a whole ampere passing through it.

Ammeters or **Ampere Meters** measure amperes.

Milliampere Meters measure the thousandth part of an ampere. They are usually so made that the pointer will register single milliamperes, 1, 2, 3, and so on, or by turning a handle the figures stand for 10, 20, 30, and so on. Or by turning the same handle still further the figures will stand for 100, 200, 300, and so on. See page 31.

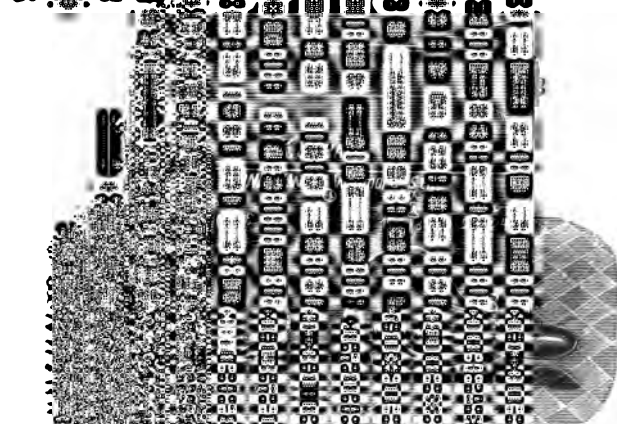
Medical cells and batteries give an even flow of current in one direction, namely, from the copper towards the zinc. If greater strength is required, more cells must be employed; and if less strength is required, some of the cells must be disconnected or cut out.

Collectors are contrivances used in medical batteries to enable us to add on cells without breaking the current. If a break takes place, the patient experiences an uncontrollable jump affecting his muscles. The chief forms are the plug, the sledge, and the dial collectors.

The simplest plug is a bifurcated or split rheophore or wire, having two pins which fit into connections with all the cells. The unsplit wire is stationary and should not be moved when once secured; whilst the second rheophore is bifurcated or split at the battery end. There are several sockets in a row on the box containing the battery; on placing one of the pins in one socket, the effect should be noticed, and, if not strong enough, the second pin of the bifurcated electrode is placed in

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28 MEDICAL ELECTRICITY FOR NURSES

the other end of the battery are much less frequently used. To obviate this the **double-handed dial collector** was introduced. By its action the cells at the other end of the battery may be used whilst the first few are out of use. The dial crank must never lie on two studs or short circuiting occurs.

Current Reversers are very useful attachments enabling the poles to be altered without detaching any wires.

Rheostats are either solid or liquid. The solid are usually coils of German silver wire so arranged that the current has to pass through a long or short length of it. German silver wire has a high resistance to current electricity, and if much be interposed in the circuit, a proportion of the current is abstracted from the circuit and dissipated in the form of heat. The liquid form of rheostat consists of a long glass tube having metal attachments at each end. One end is movable and actuated by a screw. The tube is filled with either pure water, milk and water, or solutions of copper or zinc. Having attached the wires at their proper terminals the current finds the fluid interposed in the circuit, and the strength can be regulated by screwing the movable end up or down, nearer or further from the opposite end. They are very efficient for small currents for short times, but heat and boil if used for large currents or for a long time at a stretch.

Rheophores are the pliant wires extending from the battery to the patient. They should always be

covered by insulating material. . They should be carefully handled and never bent at an acute angle, and above all never be wetted with any solution of any salt.

Electrodes are now taken to mean the covered pads which actually touch the patient's skin. They are usually made of lead, tin, or pewter covered over with several layers of gauze. They may be of any size from a threepenny bit to several feet long, and perhaps six inches wide. They would still be called electrodes. The object of covering them is to prevent the naked metal touching the patient's skin. For this reason the layers of gauze must turn over the edge, for electricity is denser at any edge or point, and an unguarded edge might cause a blister to form on the skin and prevent further treatment at that spot. According to the thickness of the gauze, eight to sixteen layers are usually sufficient ; but a thickness of gauze which would be quite sufficient for 10 milliamperes of current would not be sufficient for double that number.

Accumulators or Secondary Batteries. These are essentially plates of lead arranged in a suitable receptacle in such a manner as to store up, by chemical change, a current of electricity after being in series with a direct current for a certain time. The receptacle, or containing vessel, must be filled so as to cover the lead with a solution of sulphuric acid and water. As this evaporates it is not necessary to add more solution but water only, as the acid

30 MEDICAL ELECTRICITY FOR NURSES

cannot evaporate. They are usually placed in a wooden box, and this is marked + (plus) positive, and - (minus) or negative, and it is the + end which is coupled up to the + end of the charging current, and the - (minus) end to the - (minus) wire. The current from a secondary battery is unopposed by any polarization, *i.e.* resistance, and hence is very powerful. A battery of accumulators, the rheophores of which were allowed to touch by naked metal would heat and boil and be destroyed, whilst the covering of the wires would char and even burn. This is called short circuiting. Never allow short circuiting, even for a second or two, when using secondary batteries.

Pole Finding Paper. This is blotting-paper impregnated with a colourless salt. The paper must be thoroughly wetted, laid on a plate or piece of glass, and both poles of any battery placed on the wet paper about half an inch apart. The battery having acted for two or three minutes, the paper under one of the poles is found to be red. This is the negative pole.

The terms **Kathode** and **Anode** were originally used to denote currents coming from some other source of electricity than a primary battery, such as induction machines, dynamos, and the like. Of late years machines for the production of electricity have so much displaced the earlier primary batteries that these terms have been retained to denote the poles of primary batteries also. **Anode** denotes the

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LECTURE III

GALVANISM: A SITTING DESCRIBED

HAVING mastered the meaning of these terms, we may now attempt to describe how a sitting for the application of the direct current to a patient is conducted.

When giving a patient a sitting for direct current electricity, first procure a convenient chair or couch for the patient. Protect it where necessary with waterproof cloths or bath towels, and remove the patient's clothing sufficiently, but avoid causing chill. Procure a vessel of tepid water and swab of cotton-wool. A small quantity of real salt powdered for table use added in the strength of a teaspoonful to a pint of water is advisable in these sittings. Wet the pads in this solution; also by means of the swab, the patient's skin. Placing the pads where prescribed, see that the cells are at the weakest; and switch on the current. See that the pads are in good contact with the skin, and keep them there all the time by means of bandages, towels carefully pinned, or pressure from a sand bag. The current passes through the patient's skin to the

parts underneath, from the pads. The pads, therefore, must never touch each other, but be on opposite sides of the limbs or body, or at all events as far from each other as can be arranged.

Switch on more cells slowly until the milliampere meter shows the prescribed current, or the patient complains of feeling the pads too hot.

Remember that small pads and strong current give great pain, and large pads and imperfect contact give pain and even blisters.

The weight of the patient by sitting on a pad often helps in securing good contact. The active pad is the one used at the affected part. The pad used to complete the circuit is called the indifferent pad, and must always be larger than the active pad. The indifferent pad is placed at the back, or on the abdomen, or on the thick skin of the buttock, or the soles of both feet, or palms of both hands. The patient is watched the whole time, and the current regulated. The usual length of sitting is ten minutes to fifteen perhaps.

Whilst *small pads* affect *superficial parts* such as muscles of limbs and superficial nerves, *large pads* are necessary when *deep nerves and structures* are required to be treated.

The large indifferent pad is always kept stationary, but the smaller pad may either be stationary, when it is called *stabile*, or moved up and down the part, thus kneading it, when it is called *labile*.

There is no special danger a nurse need guard

34 MEDICAL ELECTRICITY FOR NURSES

against in giving this form of electricity, except the sudden breaking open of the circuit from a loose terminal screw or pin. But she must **never galvanize a patient's head** unless a doctor is present, or has shown her the mode of doing it on the individual patient.

A weak current would be one of five milliamperes, a strong current would be one of ten milliamperes and over. If not specially directed, attach the **negative rheophore to the larger pad.**

Having accurately gauged the time by sand-glass or watch, when the prescribed time has elapsed **reduce the current cell by cell**, just as cautiously as they were put on. As the current lessens, it is quite common to hear patients say they feel it more, therefore the lessening of the current must be slowly accomplished or the pain becomes acute.

The frequency of application varies from twice to three times a week.

Certain letters and symbols are used to denote what are called electrical reactions. **K.C.C.>A.C.C.** means that with the kathode attached by means of the electrode to the affected muscle, the muscle jumps better when the current is closed or established than when the anode or positive pole is attached to the pad over the muscle. But if the letters were **A.C.C.>K.C.C.**, meaning the anodal or positive pole over the muscle gives better contraction of the muscle on closing the current than the kathode or negative, it would be useless for the nurse to apply

the kathode or negative pole to the affected muscle. She must apply the anode.

It is not unusual to use a metronome to cause breaks in the current when such is desired. A contrivance of wire dips into a cup of mercury as the metronome beats from side to side after the fashion of a see-saw. It is placed in the circuit between the battery, or rheostat if one is used, and the patient by means of a short wire and the rheophore is attached to its other brass terminal instead of to the battery.

The Leduc contact-breaker is an instrument having certain special advantages. It is placed in the circuit between the source of the continuous current and the patient, exactly as the metronome. It would be needful for the medical officer to set this instrument in the correct position; a nurse might be trusted to set it in a similar position afterwards.

There are other instruments used for the purpose of modifying the current in the manner and frequency of its being broken and closed, but each is interposed in the same position.

But the constant current should never be broken during its administration unless the medical attendant has prescribed it. It should be *gradually* increased from very weak to the strength prescribed, and reduced at the end of the time *even more gradually*.

It may be here mentioned that in private nursing

36 MEDICAL ELECTRICITY FOR NURSES

nurses will hear often of dry cells. Water is not used in such cells, which are sealed up airtight, and can be turned upside down and sent by rail very conveniently. Zinc and carbon are still the two metals, but a damp chemical powder takes the place of water. They will last nearly a twelvemonth with ordinary use. It is cheaper to buy new cells than renew them.

LECTURE IV

FARADIC ELECTRICITY

IN the year 1831 Professor Faraday made important discoveries which may be thus epitomized.

It has been explained that insulated wire is taken to mean copper wire covered with some insulating material such as cotton, silk, gutta-percha, pitch, or a combination of each. The copper wire may be of any thickness, so thick it is difficult to bend, or so fine as to be difficult to see.

Faraday found that coils of insulated wire wound on a frame, spun quickly round so as to approach and retire from a strong magnet, had a current of electricity induced in it.

Secondly, he found that the magnet could be supplanted by another framework carrying insulated wire, through which a current of electricity was passing. That, equally, induced a current in the rotating coil.

Thirdly, he found if the two circuits above alluded to were stationary, and the current passing through one were *suddenly broken*, a current was suddenly established in the other provided they were close

38 MEDICAL ELECTRICITY FOR NURSES

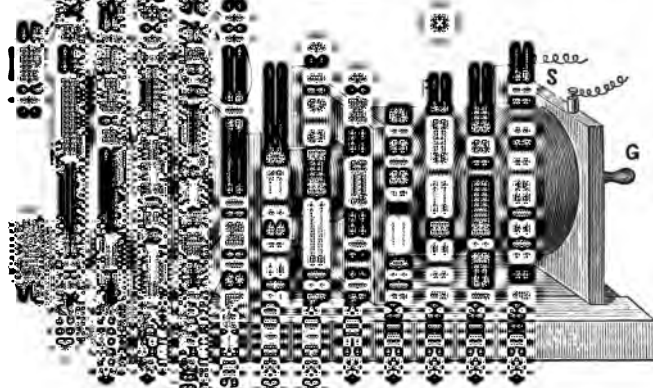
together. He found also that *suddenly establishing* the current equally caused a current in the other.

Fourthly, he found if the experiments were repeated with the wire carefully wound, as on a reel, if the reel were pierced in the centre by a mass of soft iron so that it became temporarily a magnet, all these effects were much stronger. Instead of using coils of wire on framework he used reels wound with insulated wire, making them in such a manner that the second reel could be slipped over the first.

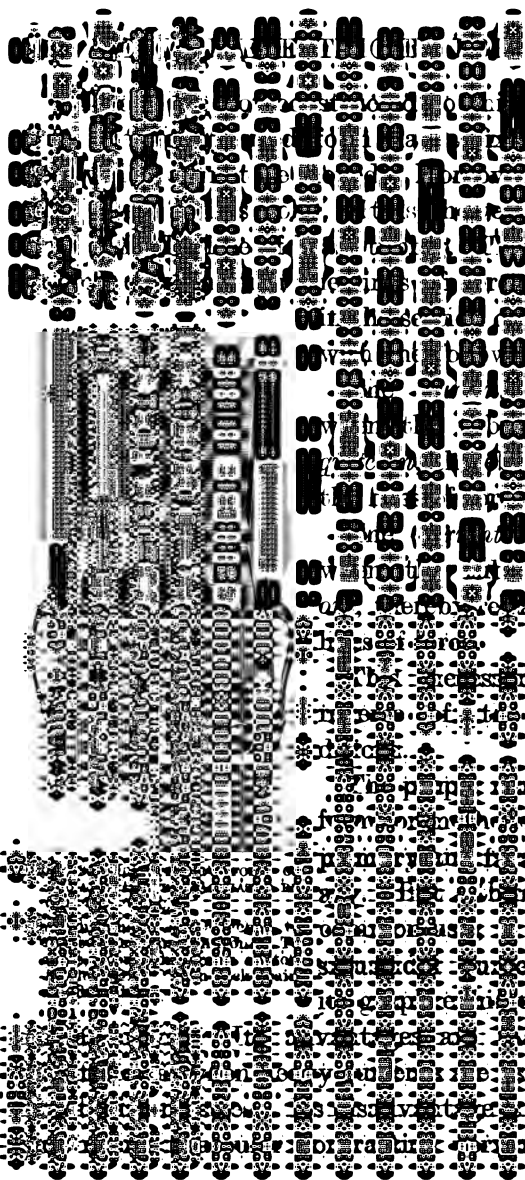
These discoveries led to the arranging of what is now known as the faradic machine, one of the most useful of medical electrical apparatus. A modern instrument has first a base board. On this is fixed the first or primary reel of insulated wire containing the iron core of wire lengths. This primary reel is actuated by a primary cell or battery so arranged that the current is incessantly made and broken by a trembling spring. The wire wound round the primary reel ends in two brass terminals. Two rheophores are attached to them, and through the electrodes to the patient. The strength is regulated by either pushing in or withdrawing the core.

Over this primary reel and in no way attached to it, except by its being so close to it, is the secondary reel. This winding necessarily has two ends which are also attached to the same brass terminals as the primary winding is. There is, however, a switch so arranged that the primary, indicated by the letter P,

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NURSES

plan, and a secondary the core is r, sheathed thick brass alluded to magnetism, result: is weakest is pressed cutting all is strongest is pulled decreasing all the is the core con- of these are faradic primary faradic second- form is in is called the current, because is the sinu- that it is not ed, nor does that it does readily, and

therefore is not usually selected for the treatment of paralyzed muscles. But its advantage lends itself to use in immersion baths, where it is the method of choice for cases of rheumatism or gout.

Whilst the sinusoidal current is the least painful form of current, it lends itself to duplication and reduplication, which neither of the previously mentioned forms do.

Thus it is possible, as it were, to engraft on one machine, a second, and even a third, all actuated by the same magnet, but giving their impulses one after another. These impulses are called **phases**, and a common number to use is three, or two. The current is then spoken of as three-phase sinusoidal current, or two-phase. The regulation of the strength is accomplished by sliding coils one over the other, as in faradic machines, or accelerating the speed of the rotations. Remember that when using two-phase current the two acting coils on the board must be slid one over the other slowly, cautiously, and both evenly ; whilst, when using three-phase current, all three sliding coils must be manipulated simultaneously, or as nearly so as possible.

A sitting for **faradic primary** current is conducted nearly exactly as one for continuous current. Thus the couch, the waterproof, the towels, the rheophores, the electrodes, are all precisely the same. But for wetting the skin we use **tepid water alone**. No salt should be added. It is, however, necessary to remove the pad from time to time, as this form of

42 MEDICAL ELECTRICITY FOR NURSES

current is of all forms the most cramping to the muscles. *Its tetanizing effect is very great.*

The indifferent pad is placed as usual on the thick-skinned portions of the body and is perhaps 4 in. × 7 in., whilst a smaller, one- or two-inch pad mounted on a handle, is placed on the muscles prescribed for. Or a roller electrode may be used in the labile method.

It would be wrong of a nurse to keep a pad actuated by the faradic primary current continuously at one spot without breaking the current. As this breaking of the current cannot be well done when a limb is immersed in a pan, various machines are made to do this automatically. They are sold under the name of rhythmic regulators. One is interposed between the faradic machine and the electrode on one side, it is immaterial which. They are commonly arranged to work by clockwork, and require to be wound up. In large hospitals and other establishments, they may be made to work by electricity. With such an apparatus not only limb baths can be used but entire immersion baths; and faradic primary baths, with rhythmic regulator adapted, prove most beneficial for many ailments.

The time a sitting should last, unless specially ordered, would be from ten to fifteen minutes twice a week, increased to alternate days, and, when tolerance has been established, even daily.

When a nurse is applying faradism to an infant r child since the dose cannot be measured as the

direct current can, she should moisten one of her own hands, apply it to the affected limb of the child, and administer the current by placing the pad on her own hand. She can then regulate the current to the proper strength, remembering that the child's paralyzed muscles will be less sensitive than her own healthy muscles.

A sitting for faradic secondary current is precisely the same as that for faradic primary. In this instance the rhythmic regulator is not an actual necessity, but may be found useful. All other things remain the same.

A sitting for sinusoidal current if applied to limbs would still be the same, but it is more commonly used by means of the immersion bath or Schnee's four-celled bath.

The size of the pads is relative to the depth of penetration in this form of electrical treatment as in that of the constant current. The larger the pad, the deeper the penetration. In this as in all forms of medical electrical treatment, the pads must be held firmly against the skin. A very light touch causes blistering from imperfect contact. They must be moistened during their use, especially in hot weather.

ELECTRICAL BATHS

Static electricity does not lend itself to administration by means of immersion in water. The term is used, however, but an electrical bath by

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the carbons, or blistering may occur. Any of the forms of galvanic or faradic electricity may be thus administered, but usually the direct continuous current is the kind given. The rheophores are bifurcated or split, so that they may be distributed to the four pans. The water is made slightly saline, and the current is carefully adjusted by means of the rheostat.

A nurse cannot be too careful to adjust the rheophores to the brass terminals firmly, and the wires should be so adjusted that an accidental twitch shall not pull it out, but in towards the terminal. A nurse should not move about near the patient, the wires must necessarily lie on the ground, and shoe-buckles, buttons, or chatelaines have an unhappy facility for catching them. She must reflect that these pans or baths allow a much heavier current to pass than ordinary pads. That the sudden breaking of the current, when five to ten milliamperes are passing, give a very undesirable shock, but with currents of twenty milliamperes and upwards the shock might be serious.

The nurse must ascertain from the doctor how the poles are to be assorted. The length of time is from ten to fifteen minutes.

Ionic Treatment, called also **Cataphoresis**. This has been coming more and more into vogue, and patients almost always express themselves as improved by it. It consists in introducing drugs through the skin close to the affected part by means

46 MEDICAL ELECTRICITY FOR NURSES

of the direct continuous current. Large pads consisting of gamgee tissue, or layers of lint and cotton-wool, are completely soaked in a solution of the drug prescribed, wrung moderately, and applied to the affected joint. A chain-mail electrode is placed over the pads, and attachment made to the proper pole of the current, and the whole firmly bandaged on. The usual indifferent pad soaked in saline solution may be used at the back, or if symmetrical limbs are affected two active pads may be used. One of the commonest drugs used is lithium iodide. If the drug is acted on by the positive pole, lithium is introduced through the skin; whereas if the negative pole is used, the iodine is introduced. By using the poles alternately both the iodine and the lithium are introduced locally, and do more good than the combined salt by the mouth.

Therefore the nurse must be most particular in enquiring which pole is to be attached to which pad.

A sitting for ionic treatment through the unbroken skin lasts from half to a whole hour.

But ionic treatment is used for open ulcers also, usually a salt of zinc being used. The ulcer may be edged with strips of gutta-percha tissue first, and eight to twelve thicknesses of lint soaked in a solution of zinc sulphate, cut the size and shape of the wound. A piece of plate zinc a little smaller is placed on the lint and connection established with the positive rheophore. The negative is attached to the indifferent pad, soaked in saline solution, and the

current established, and very slowly increased. Remember there is no skin to deal with and a very weak current will take considerable effect. Ten minutes is considered long enough when treating an ulcer or lupus.

A total immersion bath must be given in a china-ware bath. Special arrangements are made for conducting the water away from the bath, for in large towns **earth currents** from tram lines, leakage from electric lighting mains, and even "telegraphic earths" cause medical instruments to betray considerable currents. Magnetic storms occasionally are reported during which time the earth has free electricity in current form. The porcelain bath must therefore be insulated on a dry floor. The inflow of water hot and cold must take place through a yard or more of india-rubber tubing, and **these pipes must be removed** from the bath and placed in a vessel to drip **before** the patient goes into the water. Whilst the patient is putting on the bathing costume, the nurse should arrange the plates of copper in their open wood receptacles at the head and foot of the bath, inside. The rheophores attached to them in the manner above alluded to, so that a sudden accidental pull shall pull the wire towards the terminal, not from it. The rule is that the current shall be established before the patient lies down in the water. The water should not be more than sixteen inches deep. If more, the limbs float; and a paralyzed patient is very helpless and unmanageable. The

48 MEDICAL ELECTRICITY FOR NURSES

water must be pure plain water. There must always be two copper plates, one at each end of the bath, and occasionally there is a cross-bar for the hands also, laid across the top of the bath. This bar must be used when the three-phase current is used. Remember to be most particular in adjusting the current slowly, especially if the direct continuous is in use.

Very large currents are borne in baths, from one to two hundred milliamperes, and the raising and lowering of such formidable currents must be a matter of great care and caution, and even anxiety.

Electric lamps are quite out of place in the electric bath room. Fatal accidents have happened from patients trying to manipulate the lamp switch whilst still in the bath.

The temperature of an electric immersion bath should not exceed 99°-100° F. Hot water always makes the skin red, and so does electricity. When both are being used, the skin contains a very large amount of blood, becomes very sensitive, and is easily chilled.

An electric immersion bath lasts from ten to fifteen minutes, and may be repeated twice or three times a week.

Rhythmic regulators may be used in conjunction with electric baths with faradism, and are coupled up in the manner already stated.

Metronomes are not used with immersion baths.

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50 MEDICAL ELECTRICITY FOR NURSES

to attach the negative rheophore to the needle carrier as soon as the surgeon came. The part operated on should be aseptically prepared as for any other operation. She would stand by the rheostat and move the switch slowly as the surgeon asked for more current. Only five to ten milliamperes are usually found necessary. It is well to weaken the current before withdrawing the needles should more than five milliamperes be used. An anaesthetic is usually necessary in the case of infants.

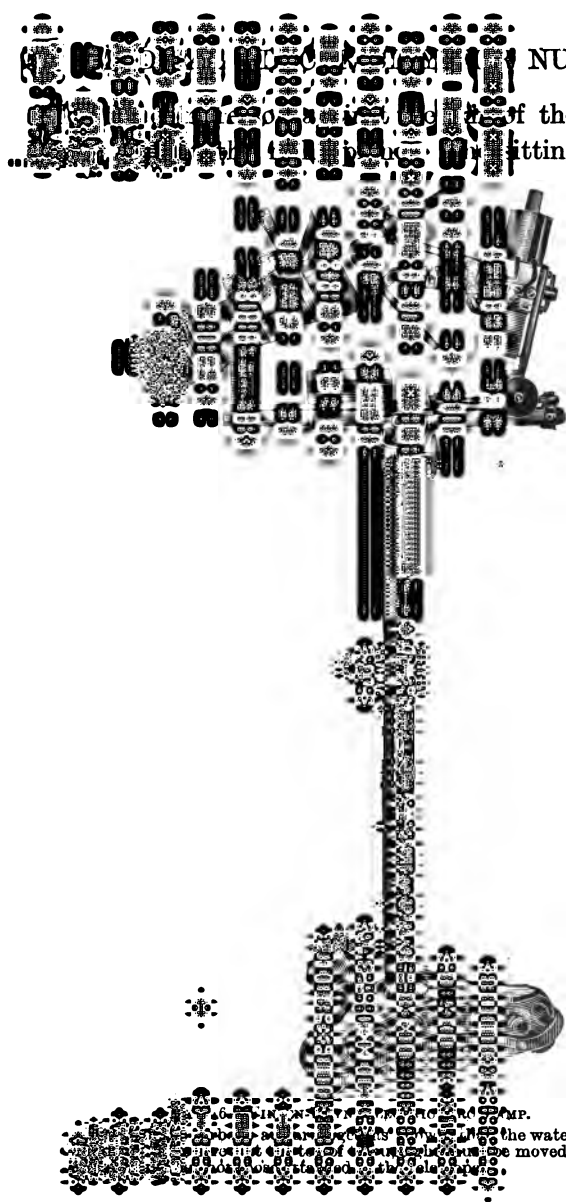
In private nursing a Spamer faradic machine is often used. It is upright in a small deep box, and is actuated by a small bichromate of potassium primary battery. The glass receptacle must be three parts filled with solution, made by a chemist, and the cover holding the zinc and carbon rods replaced. The zinc is held by a brass rod having an elbow joint. Extend the elbow and press down when wanted for use. Be most particular to pull up the zinc, and bend the elbow before putting the battery away. It wastes otherwise.

LECTURE V

FINSEN LIGHT TREATMENT. ULTRA-VIOLET LIGHT. RADIUM. ROENTGEN X-RAY TREATMENT

FINSEN light treatment as used in Great Britain is obtained from the electric arc. There are three principal instruments with several modifications. The first, and most expensive, is a large central electric **arc lamp** having four telescopes radiating in four opposite directions. These condense the light to a point by means of lenses, which, however, must not be made of glass, but of rock-salt or quartz-crystal, and are consequently expensive. Glass has the property of stopping ultra-violet light, and it seems probable that much of the benefit obtained from this form of treatment is derived from this ultra-violet light. Four patients lie at convenient distances and angles, so that four couches can be utilized simultaneously. Four nurses are employed, one to each patient lying on the couch. Water circulates between the lenses in the telescope to absorb the heat rays as much as possible, and the nurse's duty is to regulate the flow of water by means of taps provided, and to press certain quartz lenses,

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whole hour, and to maintain during that time even pressure, and the patient in the exact right place, taxes all the resources of skill and tact the nurses possess. The blood in the part has to be removed by this pressure, for the light will not go through blood; and the nurse must not be satisfied until she sees the part well blanched. It is not right for nurse to look at this bead of light with unprotected eyes; she must wear dark glasses made for the purpose. Neglect of this precaution may lead to serious consequences to the sight. **The plane of the lenses in the telescope and that of the compressor lenses must be parallel.** The tendency of the patient is to give way to the pressure of the nurse's hand to ease pain; nurse has to continually rectify this failing.

Owing to the large expense attending the cost and upkeep of these original Finsen lamps, it is more usual to find the Finsen-Reyn lamp used. It has but one smaller arc lamp and one telescope. One patient only can be attended to at a time, and one nurse and one couch only is required. The directions concerning the circulation of water, the action of the compressor, and the care of the patient and his attitude are the same as above. The length of time required for a sitting is one hour.

The **Condenser Spark** apparatus is an efficient means of obtaining ultra-violet light. The terminals between which the spark leaps are of iron instead of carbon. The spark is obtained from an induction

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willemite, which is usually sent with the instrument, or, failing that, a smear of vaseline. This latter glows a fine blue colour, but a sheet of glass interposed at once puts it out. The willemite glows grass-green, which goes at once when the glass filters out the ultra-violet light. These effects are best seen in an almost quite dark room.

Prior to using such apparatus on a patient, a nurse should give him a bowl of Lysol and water and a swab, and superintend the removal of all dry scabs or scales. This applies to all the different forms of Finsen light and X-ray administrations also.

Although **Radium** has been written of and made use of so extensively of late, it scarcely enters into a nurse's duties other than seeing the patient does not remove his dressings. It is usually sent out enclosed in very small tubes of silver or gold.

For a nurse's information, it may be here stated that radium, obtained from pitch-blende, is sent out in the form of bromide or sulphate of radium. It occurs as a white powder and is spoken of as pure radium. But the metallic form of radium is not known except as a laboratory product of a very few grains. The nurse will notice in the box in which it is sent a label setting out its activity. Pure radium bromide has an activity of *two million uranies*. Equal quantities of bromide or sulphate of radium and barytes mixed gives an activity of one million uranies. There are weaker strengths made and used, but it is doubtful whether any strength below one

56 MEDICAL ELECTRICITY FOR NURSES

million uranies is of medical use. The active radium salts give off alpha, beta, and gamma rays, and an emanation. The alpha rays are extremely irritating to the skin, and for this reason the radium salts are enclosed in thin tubes of gold or silver which stop these dangerous soft rays, not allowing them to leave the tube. The beta and gamma rays permeate not only the skin, but the deeper tissues also. The tubes are not allowed to touch the patient's skin, but are kept at a slight distance from it by layers of lint, six or eight in number. Over a wound a piece of gutta-percha tissue is first placed, then the layers of lint, then the tube or tubes, lastly a strip of sticking-plaster to fasten the tubes securely to the lint. This is carefully bandaged on so that no shifting can occur.

Radium is kept on the patient many hours, four, eight, or twelve, as it is prescribed. Sometimes two hours daily or four hours every other day for twelve days. Then the case may be watched and the effect noted. The treatment may be repeated in two, three, or four weeks. The method of **cross fire** is to make the rays enter both sides of a tumour; in the case of a hand, a tube may be placed above the tumour at the back and another at the palm of the hand. Another method is to place celluloid capsules containing radium salts in the centre of large tumours by operation, and keep them there several hours for several days.

The gold or silver tubes may be carefully cleaned

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58 MEDICAL ELECTRICITY FOR NURSES

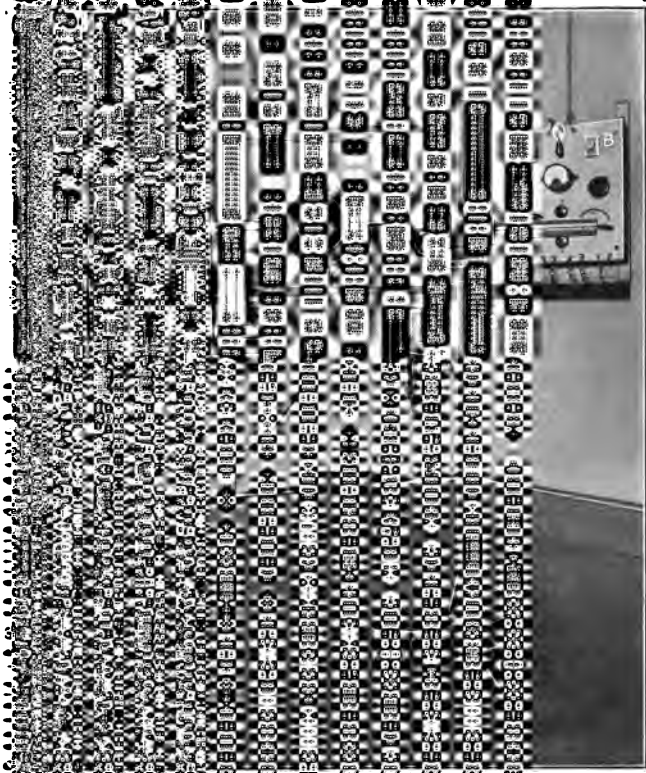
by enclosing the plaster in gutta-percha tissue. The plasters seem to deteriorate gradually, and the plan has not found much favour in England.

Besides alpha, beta, and gamma rays, radium gives off an emanation, which is a kind of gas. It can be conveyed along tubes and condensed by cold. Water can be impregnated with it, also certain drugs. It is believed to be present in many natural hot springs, which thus prove beneficial, both internally and externally, as a bath. The relief from the pains of rheumatism by frequent immersion in some natural springs is believed to be due to this impregnation, and the springs and accompanying mud are spoken of as radio-active.

Roentgen or X-rays.—Conrad Wilhelm Roentgen of Vienna discovered what he called X-rays during the winter of 1895-6. To show them it is necessary to have a very large and powerful induction coil. Such a coil is constructed on the same principle as the faradic coil—one coil sliding over the primary—but they are immensely stronger. A nurse must never touch one during the time it is in action. The shock such powerful coils give affect the respiratory muscles and even the heart; it must be scrupulously avoided.

Instead of the vibrating faradic hammer, some form of mercury break is used capable of passing a heavy current. An X-ray tube is next required. They are large, brittle, and very expensive. A nurse must be most careful in handling them, especially

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60 MEDICAL ELECTRICITY FOR NURSES

To couple up the apparatus for an X-ray examination, we therefore require a source of electricity in the direct continuous form. This is brought to the induction coil brass terminals by insulated copper wires. Next, the mercury break is set in action and time must be allowed for the instrument to gather its speed. Next, the attachment between the induction coil and the X-ray tube is made, and the commutator turned on. The tube can now be seen to glow of a greenish-yellow colour as soon as the room is made dark. The cathode or negative end of the secondary coil is attached to the cup-shaped cathodal end of the X-ray tube, whilst the positive end is attached to its opposite end by insulated wires. The tube is working correctly when all or nearly all the greenish-yellow light is in front of the flat plate or target in the centre of the glass globe. When rings of the same colour appear to move in the tube and illuminate the back of the glass as much as the front, it is incorrectly coupled up, and must immediately be stopped.

Naked tubes must never be used; they must always be placed in a shield. This may be of glass specially prepared or a box lined with a composition impervious to X-rays, or with thin lead.

If a nurse has to hold a patient during the administration of X-rays, she must put on gloves prepared for the purpose.

When a patient is brought into the dark room for examination, if the patient requires no special help,

a nurse should stand a little way back with her hands behind her.

A nurse is often asked to give a patient a bismuth meal, and this requires great care and judgment in a quite dark room.

A patient whose kidney region is to be examined must be prepared by house medicine and enema exactly as though an operation were going to be performed. The examination is useless otherwise, for the contents of the intestines give shadows quite like calculi.

X-rays are often used as curative agents for certain diseases.

It is of immense importance to be particular as regards the distance the tube is from the patient's skin, and the length of time of the exposure; a nurse must be most particular in observing the sand-glass or listening to the alarm-clock.

Filters are used for X-rays as for radium. A filter may be of any substance, felt, aluminium, impregnated lint, etc., and a nurse must be most particular in understanding her instructions and carrying them out.

In order that the part of the patient affected should be the part on which the X-rays fall and no other, cylinders of lead or lead glass are made of certain sizes and length. The nurse assisting in an electrical department should be most particular in correctly mounting these cylinders, and seeing that the target or anti-kathode is in the centre of

the circle of the cylinder. The **fluorescent screen** is quite necessary to determine this. On viewing the glowing tube with the fluorescent screen, if the tube and cylinder are correctly placed, the circle of illumination appears clean cut all round. But if they are not correctly placed, the appearance is that of the three-quarter moon. In trying this experiment the screen may almost touch the end of the cylinder, which may be a narrow one.

The fluorescent screen for X-ray work is taken to mean a tightly stretched material, such as parchment or cardboard on a wooden frame, on one surface of which has been painted a varnish containing a large quantity of platino-cyanide of barium. This salt has the property of fluorescing bright yellow when X-rays fall on it. The screen must be next the observer's eye, next comes the patient, and about six inches behind the patient the tube in the shield.

When the fluorescent screen is adapted to a stereoscopic box, the whole arrangement is called a kryptoscope or sometimes a fluoroscope. The advantages of the box addition is that the part may be viewed in a moderately lighted room. But when the open screen is used the room must be so dark that the objects in the room are not seen.

Photographic pictures of the bones and some of the viscera can be obtained by means of X-rays acting on the bromide of silver in dry photographic plates. To obtain such a picture, the patient must

be absolutely still. Nurses are often asked to help in keeping the head or limbs quite quiescent. Boards, blocks, and sand-bags greatly help to this end, but a nurse can help also if she will herself keep quite still.

It should be remembered that the bones and viscera inside a living subject are similarly held as fruit in a jelly. The very slightest touch or jerk causes a wobbling which does not quite cease for some seconds. This causes a woolly appearance in the photograph, and an indistinctness which may obliterate a fine line of fracture. Therefore, if a leg be photographed, even the arms and head must all be kept absolutely quite. And if a nurse be assisting with her hands, her own head and feet must all be absolutely quiet. She must not lean against the couch nor walk about the room.

A nurse in charge of an X-ray outfit should preserve all the leaflets sent out with each portion of the apparatus and read them carefully. The makers describe in them their own instruments and show how they should be used. This applies to the various makes of tubes for the production of X-rays also.

In the section on static electricity attention was drawn to the fact that a Wimshurst eight-plate machine was useful for other things than those described. Such an instrument can be used to cause an X-ray tube to glow. It is not so efficient as the induction coil for this purpose, but for thin portions

64 MEDICAL ELECTRICITY FOR NURSES

of the body, fingers, hands, toes, and even forearms and lower legs, it is fairly efficient should a coil be unattainable or temporarily disabled.

The two ends of a Wimshurst must not be attached to the two ends of the X-ray tube, but the negative conductor must be attached to the cup-shaped kathode by the loop of the X-ray tube by means of a cable or wire well insulated, whilst the anode conductor cable is held so that a sheaf of sparks occur between it and the anode end of the X-ray tube. The influence machine has to be worked briskly and made to do its utmost. Shaking the instrument and so shaking the tube must be avoided.

X-rays pierce almost every substance as do magnetic lines of force, but with much greater differentiation. Thus almost every conceivable substance has been tried, such as wood, skin, leather, vulcanite, india-rubber, all the metals, flock, wool, paper, felt. But the experiment amounts to this, that every substance has its own density to these rays. When Roentgen appreciated this he tried whether living flesh was pierced by these rays, and, if so, whether the bones stopped the rays in any different manner than the flesh. He tried his own hand, and was interested to find the bones did retard the new rays in a different degree to the flesh. This was the beginning of X-rays being applied to medicine and surgery.

When X-rays are allowed to fall for a length of time on the scalp where the hair is growing, in a few

weeks the hair is found to be thrown off the root bulb, and temporarily a bald patch occurs. This process has been worked out very thoroughly by Dr. Sabouraud of Paris for the cure of ringworm and favus. When the ringworm is situated in patches more or less isolated, the patches are treated singly by placing a suitable cylinder of metal or special glass on the X-ray tube shield and so arranging the apparatus that the ringworm occupies the centre of the space on the scalp on which the cylinder impinges. But when the ringworm is scattered all over the scalp, the cylinder is done away with and a *Kienboeck adaptor* is used instead. This adaptor has three wooden points or legs projecting so that they may rest on the scalp. The medical officer in charge will, for those cases, have made certain marks on the prepared head, and the nurse's duty is to see that the points of the adaptor are allowed to remain where they were placed, for children are apt to shift the head from restlessness. For the scattered form of ringworm it is necessary to clip the hair all over with clippers. In the isolated patch form it may not be absolutely necessary, but in the case of girls with long hair, if it is not clipped all over, cylinders apparently much too large must be used, for islets of disease always surround the large patch.

The length of time the X-rays are allowed to fall on the scalp will be ordered by the medical officer in charge, as it differs with each induction coil and tube. But the nurse should be aware that the time depends

66 MEDICAL ELECTRICITY FOR NURSES

on the colour a little disc, called a sabouraud, placed in the adaptor, assumes. She will be given a little case containing these sabourauds, and in it a coloured pattern, and the X-rays should fall on the scalp until the little disc becomes that colour. To make this correct, the exhibition is made in a nearly dark room. There is a special place made for the reception of a disc in the shield, and nurse must not forget to place a fresh one in each time with the *yellow side towards the tube*.

Nurses who hold the head of the child, which is seldom necessary, must not rely entirely on the shield, but put on protecting gloves also.

The original directions of Dr. Sabouraud were that, besides working in a dark room, the colour of the disc was to be judged by artificial light. This has recently been disregarded and daylight or special blue light used. The point is very important, as the matching of the colour varies very notably with the light used. The nurse in charge will take her directions from the medical officer. The discs bleach rather quickly in daylight.

It should be a matter of common knowledge amongst sisters and nurses that all fractures requiring, as they nearly all do, two photographs taken at right angles to each other must be sent to the electrical department specially prepared. Whether in private nursing or in hospital, the splints must be

arranged so that nothing but wood or aluminium intervenes between the photographic plate and the X-ray tube and the limb. X-rays penetrate all forms of padding and bandages fairly well ; but zinc, iron, plaster of Paris, gauze impregnated with iodoform, or the metallic solutions are impervious. If a limb lies on an iron splint, the sister or nurse must arrange the bandages so that the photographic plate may be placed between the splint and the limb.

It should also be a matter of common knowledge that a photographic plate, even in a wooden box or light tight envelopes, must on no account be taken into a room in which X-rays are in use ; not even carried through. That wood is quite transparent, as well as the envelopes the plates are usually wrapped in, to X-rays. And it would appear that it is necessary to tell nurses that photographic plates are spoiled if taken out of their receptacles in daylight, or ordinary artificial light, to be looked at. Photographic plates can only be manipulated in the photographer's " dark room," which is lighted by a special " ruby light," until they have been developed and fixed.

When X-ray photographs are taken in private houses, nurses must realize that wire wove or spring mattresses are not very suitable, and arrange for a table with blankets being used instead. Also, they should see to some means being taken to render the room dark, for the medical man judges of the

68 MEDICAL ELECTRICITY FOR NURSES

working of the tube by its appearance, and this cannot be observed in a very bright light. A successful photograph cannot be taken if people lean or sit on the bed, nor if the floor is shaken by people walking about.

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70 MEDICAL ELECTRICITY FOR NURSES

rods the two wires from the induction coil must be fastened securely. Inside the glass tube or cylinder must be placed several pieces of unslaked lime. These must be renewed every week. In front of this glass cylinder is seen a coil of coarse wire with nothing on the wire to insulate it. A spring carrying a round knob is found pressing against this coarse wire. This spring requires to be moved a few turns to the right or left according to whether the patient is fat or very thin. The coarse wire is called the *solenoid*. Two wires are so arranged they can be brought from the solenoid to the patient.

The patient is treated by a wire or cable attached to one terminal of this solenoid, while the other terminal is either earthed by laying the insulated cable on the ground or is also attached to the patient at some other part. This is called the bi-polar method. Wet pads are interposed as in galvanism.

Dr. Oudin invented what he called a *resonator*. A long coil of copper wire is wound round a cylindrical framework of insulating material, such as polished wood. The turns must not be too close. When a proper length of wire is attached to one end of the thick wire solenoid, the resonator plays the part of a resonating box of a tuning fork, and, similarly, greatly intensifies the effect. A sliding contact by which a proper length of the resonator may be included, and when the solenoid and resonator are thus properly tuned, the upper end of

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72 MEDICAL ELECTRICITY FOR NURSES

There are three chief methods of applying the high frequency currents :

Local application.

Auto-conduction.

Auto-condensation.

Local applications can be made by directly connecting the patient, by means of wires and moistened electrodes, with either end, or with a certain number of spirals, of the solenoid ; or by approaching him (effleuve) or touching him with an electrode attached to the resonator or bi-polar transformer.

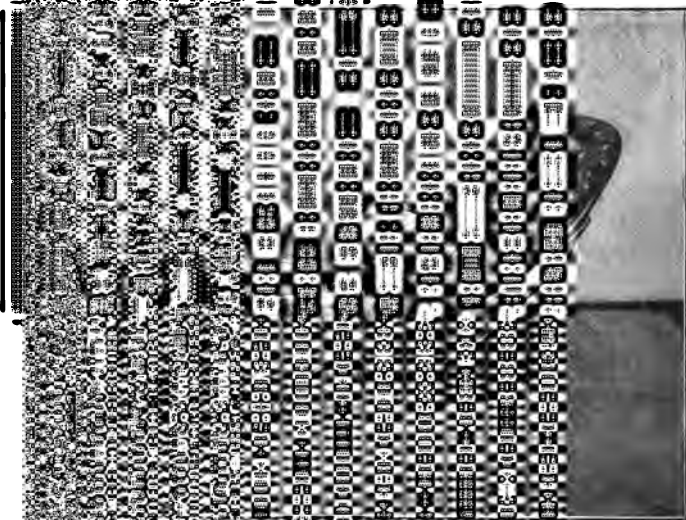
In auto-conduction the patient is placed inside the solenoid, which is made large enough to take him and a chair, and he becomes the seat of induced currents.

In auto-condensation, which is the more frequent form of administration, the patient is made to take the place of one of the coatings of a condenser or Leyden jar, as it were.

On a couch is placed a backing of sheet metal ; over this is laid an insulating mattress of rubber or felt under the ordinary cushion. The metal sheet is connected with one end of the solenoid or resonator ; the patient lying on the cushion becomes, if connected to earth, oppositely charged to the metal plate. The insulating mattress represents the glass or dielectric. On the couch there are metal handles connected to the earth or the other end of the solenoid ; these the patient grasps. At every

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74 MEDICAL ELECTRICITY FOR NURSES

from ten to fifteen minutes. If the patient wears hatpins, it is well to remove them, but the ordinary small hairpins cause no inconvenience.

The milliamperage for a case of condensation couch treatment would vary from four hundred to eight hundred, or higher if specially prescribed.

If, whilst the patient is undergoing treatment on the couch, nurse passes her bare hand and rubs or strokes the affected joint, sparks pass leaving a feeling of warmth which often alleviates the pain.

The effect of high frequency administered on the couch is one of exhilaration and sense of well being. It dilates capillaries and so relieves high pulse tension and its depressing sensations. Sitzings should be often repeated, every or every other day, and should persist for one or two months. Its effect on Raynaud's disease and "dead fingers" is very marked.

When the brush discharge is used from the Oudin's resonator, the other extremity of the solenoid is earthed or attached to the sparking box, the brush being attached to the top of the Oudin's resonator. The tuning of this apparatus to the patient is done by moving the lower attachment, which is made movable, up or down the resonator, and noticing the length of the brush, which should be three or four inches in length. The physical effect of this form of treatment is to produce local glow and warmth. The mental effect is often very great and impressive. The brush is moved up and down the

spine or joint affected, just beyond sparking distance, for about five minutes two or three times a week. Glass vacuum tubes are sometimes used in actual contact, more particularly to the face.

DIATHERMY

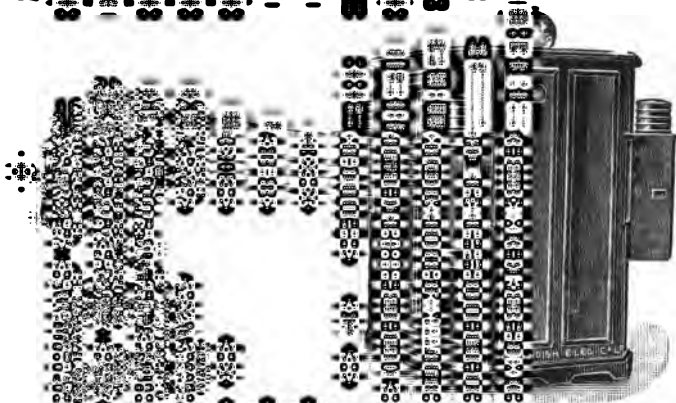
In using diathermy, a nurse would have to arrange two large pads and wet them as for faradism. Diathermy is more a local application than a general one. The high frequency oscillations are led to another apparatus which raises their tension and hence larger currents are used over smaller surfaces. It is this which governs the size of the pads. The pads should be of sufficient size to allow currents of 900 milliamperes to 1200 to pass for five minutes without giving rise to actual scorching or blistering. They should be securely fastened and evenly pressed against the affected part. The usual waterproof, towels, and a seat or couch would be necessary. The sittings are for five to ten minutes, and are repeated twice a week. They do not require very long continuance as a rule. This form of treatment is painless beyond a decided feeling of warmth.

Diathermy is used in other ways also, but the manipulations would be performed by a qualified surgeon.

A patient should be allowed to remain in the lying down position for one or two minutes after these administrations, whether of high frequency or diathermy.

THE ELECTRIC NURSES

of the electric light and heat baths. The patient is not exploited, but is benefited partly from the light and partly from the heat. The body is brought to these conditions in a convenient way of treatment, and the patient may be kept in the bath as long as necessary by this means. The patient is not only kept warm, but is also kept dry, frosted



The electric cabinet is a device for the treatment of the patient. It is a tall, dark, rectangular cabinet into which the patient is placed. The patient is not only kept warm, but is also kept dry, frosted. The patient is not exploited, but is benefited partly from the light and partly from the heat. The body is brought to these conditions in a convenient way of treatment, and the patient may be kept in the bath as long as necessary by this means. The patient is not only kept warm, but is also kept dry, frosted.

the patient carefully, for fainting and even syncope not infrequently occur. The patient must be denuded of the ordinary clothing, and bathing costume or a loose towelling garment substituted. Occasionally, and perhaps preferably, a bed couch is substituted, having asbestos blankets below and over the patient. These are kept from touching by cradles. The lamps are contained in reflecting tins, and are placed alongside the patient at a sufficient distance to avoid scorching. Small blankets are placed where the heat is unpleasantly felt, and the nurse has to be quick in altering these blankets, when asked, or blistering will occur. Such hot-air baths last quite half an hour, when the heat is let down section by section. The patient uses a towel and clothes himself again, and it is usual to remain resting a while to cool down and partake of a mild stimulant such as tea before going home in a cab or closed vehicle.

A single joint, shoulder, elbow, or knee, can be treated in a similar manner, using one tin only with its lamps.

Those who think the *actual* light participates in the cure have arranged an accessory arc lamp on the principle of the search-light, which can be made to impinge on the affected part of a patient in a cabinet. To the arc-light is added a blue stained glass only permitting the blue rays to pass, and cases are reported in which this blue light has appeared to have an anaesthetic effect on the pains of neuritis.

78 MEDICAL ELECTRICITY FOR NURSES

Red light has appeared to promote the healing of a wound.

Rheumatic patients have derived the greatest benefit from the radiant heat and light cabinet after only five or six sittings. But the cures are very uncertain.

USEFUL WRINKLES

NEVER allow any joking with any electrical instruments.

Do not touch a patient undergoing the static bath except to carry out treatment ordered.

Unless sparking is ordered, static breeze should be given just beyond sparking distance.

The most common cause of difficulty in getting the static machine to act is dampness of the revolving plates. Dryness and revarnishing are the only cures.

Sunshine impinging on the machine a few minutes acts surprisingly in causing it to work well.

In arranging the direct or constant galvanic

80 MEDICAL ELECTRICITY FOR NURSES

current, whether by switchboard or battery, if possible connect so that the plus or positive is to the right. Attach the red-covered wire to the positive terminal, the green or blue to the negative. Make this a rule.

When administering constant current, a small quantity of pure chloride of sodium added to the water used to wet the pads saves current and is pleasant to the patient, *provided* a total immersion bath is not being administered. Chloride of sodium must never be placed in a total immersion bath.

One part of the electrical circuit can never be stronger than another. It is, therefore, useless to put any greater amount of any salt into the pan in which the paralyzed limb is immersed.

Whenever a patient appears to be taking an unusual amount of current, suspect trickery. Arching of the back, and raising the hands from the pad still outstretched, appears innate with some patients.

When the constant direct current appears unsteady and the pointers never at rest, imperfect contact is almost always the cause. The terminals are the usual seat of this.

The metallic pins which are placed in the holes of the terminals often escape cleaning. They become coated in verdigris and must be cleaned with sand-paper, or, better, with emery-paper.

With this form of low tension direct current, if no action at all occurs after searching for a connection which has been forgotten, suspect the rheophores. Test each separately until the faulty wire is found, then replace with another.

Provided there are milliamperemeters, detecting this is easy, by causing *momentary contact* of the positive or right rheophore with the negative terminal first, and then causing *momentary contact* of the negative or left rheophore with the positive terminal. This causes momentary short circuiting, and the needle of the milliamperemeter *dashes violently* to the one side or the other, if the circuit is complete, but remains immovable if not so. When doing this, the rheostat should have plenty of resistance in, lest the meter should be injured. The contact must be momentary only.

Milliamperemeters commonly have shunts which are operated on by turning a wooden handle or head. This converts the units, one, two, three, four, five,

82 MEDICAL ELECTRICITY FOR NURSES

to ten, twenty, thirty, forty, fifty, and by turning the head round again to one hundred, two hundred. three hundred, four hundred, five hundred. The turning back again of this screw-head is apt to be forgotten. When turning the handle, reduce the current to zero first.

For military and other purposes small portable dynamos are made weighing about forty or fifty lbs. Two men can operate these by hand for a few minutes quite satisfactorily. But for longer time a bicycle with one tyre taken off, and the framework held just off the ground by crutches, can be utilized to operate a dynamo for charging accumulators. The two men then work singly, relieving each other at stated intervals.

- A faradic machine sometimes refuses to start. A nurse should avoid touching the tension regulating screw if possible. A touch setting the vibrator acting will usually start it. If it does not, the nurse in charge should carefully, and very slightly, turn the screw on which is mounted the platinum point. She should see exactly what she is doing and the effect of it. A carelessly screwed up point may actually bend the spring, requiring skilled workmanship to repair, and perhaps a journey to the maker.

The German silver rheostats of fine wire wound on slate must be cleaned pretty frequently. The sliding attachment hangs and moves with difficulty by degrees. The thick metal bar must then be cleaned with powder, or one of the spirituous cleaning polishes sold under the names of Bluebell or Brasso polishes. The thick bar should be rubbed longwise, but the fine wire rheostat should be rubbed gently crosswise, that is, in the direction of the winding.

No emery or sand-paper should be used to these rheostats.

Any drop of solution lying on the fine wire of the rheostat must be scrupulously absorbed by blotting-paper or cambric, and the spot carefully dried.

No solution must be allowed to wet the rheophores. They are quickly rendered brittle, and on bending they break.

X-ray tubes should not be put to full work as soon as they arrive. They should have time to take the same temperature as the rooms they are used in. Even a large tube should for a week or two be set to work on hands, feet, and toes, and perhaps used

84 MEDICAL ELECTRICITY FOR NURSES

for a short treatment case. They should be cautiously dusted before and after use.

In rendering X-ray tubes "softer" by means of the mica regenerator, the tendency is to underdo the process. The mica may glow with red splashes of light for a minute or two. But the tube should rest a few minutes after.

Some tubes are more responsive to the hot wire method of softening than others. In some a few seconds are sufficient, in others a minute or even two are necessary.

The water inside a Muller's water X-ray tube gradually turns brown. When this is so, evacuate the water. If it be hot, allow the container time to cool before putting in more cold water.

When using a Finsen-Reyn electric lamp, *if the carbons bridge* and adhere to each other, thus forming a short circuit, *at once switch off the current*. Remember this form of treatment uses large and heavy discharges of electricity, perhaps twenty-five amperes or more. During short circuit this may become heavier still and likely to injure the dynamo

or the accumulators. Therefore switch off the current at once.

When arranging a Finsen light case, keep the perforated cap on the telescope until the position and angle are arranged. Turn on the water-tap, get rid of the bubbles, and lastly remove the cap. The holes in the cap allow all focussing and centering to be done without subjecting the patient to the great heat.

The bubbles in the compression lenses are easily got rid of by turning on enough water to make them spin and dance, when a slight rotation to get them in front of the tube which takes away the water causes them to be sucked into it.

When the zinc of a primary cell is first put into the electrolytic fluid it is apt to bubble and wear away when the current is not being used. To prevent this, it must be *amalgamated*. The zinc must be first soaked in water, and all adhering crusts and dirt got off by rubbing with tow or rough scrubbing cloth. It should next be washed in sulphuric acid and water, one part in twelve. On pouring a little mercury or quicksilver, as it is also called, over it, the quicksilver is found to wet it, and makes the zinc shine like silver.

INDEX

- Accumulators, 29.
- Amalgamating a zinc plate, 85.
- Ampere, 25.
- " meters, 26.
- Anode, 30.
- Artificial magnets, 20.
- Attraction, 4.

- Barium meal, 61.
- Battery, galvanic, 23.
- Battery, Leyden jar, 17.
- Bismuth meal, 61.

- Chains for insulating stool, 13.
- Coercive force of magnets, 20.
- Coloured light, 77.
- Collectors for batteries, 26.
- " dial, 27.
- Combs, 10, 17.
- Condenser spark, 53.
- Conductors of electricity, 7, 18.
- Cryptoscope, 62.
- Current, direction of electric, 24.
- " reversers, 28.
- Cylinders for X-ray administration, 61
- " for X-ray examination, 61.

- Dark room for photographic plates, 67.
- Diathermy, 75.
- Discharge, disruptive, 7.
- " electrical, 7.

- Discharging poles, 17.
- Dry cells, 36.
- Dynamos for producing the constant current, 82.

- Electrodes, 29.
- Electrolysis, 48.
- Electrolyte, 23.
- Electrolytic fluid, 23, 24.
- " needles, 48, 49.
- Electro magnets, 21.
- Electromotive force, 18.
- Electroscope, 6, 14, 17.
- " how to charge, 15.
- Excitation, Electrical, 4.

- Faraday, 37.
- " his discoveries, 37.
- Faradic machines, description of, 40.
- " primary currents, 41.
- " secondary currents, 41.
- " sitting, 41.
- Feather attracted and repelled, 4.
- Filters for X-rays, 61.
- Finsen light treatment, 51.
- Finsen-Reyn arc lamp, 52.
- Fluorescent screen, 62.
- Fluoroscope, 62.
- Four-limbed or four-celled bath, 43.
- Frictional electricity, 8.

Galvanic battery, 23, 24.
 " cell, 23.
 " battery coupling up, 24.
 " electricity, 22.
 Gloves, protection from X-rays, 60.
 Gold-leaf electroscope, 5.
 Glass case for Wimshurst, 11.
 Glass tube excited, 4.
 Graphs, 19.
 High frequency, 69.
 " " sitting, 73.
 Immersion bath, management of, 46.
 Influence machine, 8, 9, 11, 12.
 Insulating stool, 13.
 " chains, 13.
 " chairs, 14.
 Insulators, 7, 18.
 Ionic treatment, 45.
 Iron core for faradic machine, 38, 39.
 Kathode, 30.
 Kienboeck adaptor, 65.
 Laws of electricity, one of, 14.
 Leyden jars, 10, 16.
 Lines of force, 21.
 Magnetic axis, 21.
 " equator, 21.
 " field, 22.
 Magnets, Artificial, 20.
 " electro, 21.
 " natural, 20.
 " permanent, 20.
 " temporary, 20.
 Metronome, use of, 35.
 Milliampere, 25.
 " meters, 26.
 Natural magnets, 20.
 Negative electricity, 5, 30.

Neutralizing rods, 10.
 " position of, 10.
 Non-conductors, 7, 18.
 Opening and closing current, 25.
 Pads, active, 33.
 " indifferent, 33.
 " labile, 33.
 " stabile, 33.
 Permanent magnets, 20.
 Photographic plates, 67.
 Pith balls, 5.
 Pole, 31.
 " finding paper, 30.
 Positive electricity, 5, 30.
 Prime conductors, 10, 17.
 Proof plane, 14.
 " how to charge, 16.
 " description, 18.
 Radiant heat, 76.
 " with arc light, 77.
 Radium, 55.
 " cross fire, 56.
 " plaster, 57.
 Resinous electricity, 5.
 Rheophores, 28.
 Rheostats, 28.
 Rhythmic regulators, 48.
 Ringworm, 65.
 Rods, discharging, 10.
 Roentgen Rays, 58.
 " " photographs, preparation of patients for, 66.
 Roentgen ray tubes, 59, 60.
 Sabouraud, Dr., 65.
 Sabouraud's discs, 66.
 Schnee's, Dr., four-celled bath, 43.
 Shellac attraction and repulsion, 5.
 Sinusoidal current, 19, 43.

- | | |
|---|--|
| <p>Sitting, galvanic, described, 32.
 „ static electricity, described, 13, 14.
 Sledge for batteries, 27.
 Spamer faradic machine, 50.
 Static electricity, 8.
 Temporary magnets, 20.
 Ultra-violet light, 53.
 Unidirectional action, 12.
 Vitreous electricity, 5.
 Volts, 25.
 Voltmeter, 25.
 Vulcanite, 8.
 Wimshurst influence machine,
 8, 9.
 „ care of, 12.</p> | <p>Wimshurst influence machine,
 glass case for, 11.
 „ working of, 11, 63.
 Wrinkles for amalgamating zinc
 plates, 85.
 „ on constant current,
 80.
 „ for faradism, 82.
 „ for Finsen - Reyn
 lamp, 85.
 „ for static electricity,
 79.
 „ on X-rays, 84.
 X-rays, 58.
 X-ray examinations, 61.
 „ gloves, 60, 66.
 „ preparation of patients
 for, 66.
 „ photographs, 62.</p> |
|---|--|